Sub-national inequities in Philippine water access associated with poverty and water potential

Alexandra Fehr, Murat Sahin and Matthew C. Freeman

ABSTRACT

The Philippines is one of many countries to have achieved the Millennium Development Goal target for improved access to drinking water. However, the national average masks sub-national inequities in access that underlie important information for policy makers and that have implications for health and development. We conducted a geospatial analysis on water access at the household and school levels, total water potential, and poverty incidence. We also compared water access at the household level between 1998 and 2008. We found significant spatial autocorrelation for all variables: the northern region had higher access to improved water sources, lower levels of poverty and less total water potential than the central or southern regions. Further, these trends did not change from 1998 to 2008. This study identifies the most marginalized areas within the Philippines. Our approach could be used by policy makers, donors and service delivery providers within the Philippines and elsewhere to better target water infrastructure projects.

Key words | equity, geospatial analysis, Millennium Development Goals, water access

Alexandra Fehr
Department of Environmental Health,
Emory University,
Atlanta,
GA 30322

Murat Sahin
WASH Section, Program Division,
UNICEF,
3 UN Plaza,
New York,
NY 10017

Matthew C. Freeman (corresponding author)
Department of Environmental Health,
Emory University,
Atlanta,
GA 30322
E-mail: *mcfreem@emory.edu*

INTRODUCTION

According to the WHO and UNICEF Joint Monitoring Program, the world has met the Millennium Development Goal (MDG) target for water: to halve the proportion of people without access to sustainable and safe drinking water by 2015 (JMP 2012b). It has been argued recently that this claim of 'mission accomplished' masks challenges associated with the indicators used for measuring 'safe and sustainable access' (Clasen 2012). Others have countered that the targets are over-estimated when microbiological quality is considered (Onda *et al.* 2012). Regardless, that some countries have 'achieved' the MDG target also masks sub-national inequity of where improvements to access are needed (Monsod & Monsod 2003). There is considerable sub-national heterogeneity of access to water among particular groups of people: those living in certain regions, in semi-arid climates, the poor, women, rural residents, and people with disabilities (UNICEF 2011).

Access to safe water has been declared a universal human right (UN General Assembly 2010), and though the water target is part of the MDG environmental sustainability goal, a key driver for achieving the target for drinking water is the reduction of diarrhea mortality. Diarrheal disease contributes to 1.5 million deaths per year and contributes to 6.3% of the global disease burden (Boschi-Pinto *et al.* 2008; Black *et al.* 2010). Because the most marginalized are disproportionately burdened by high rates of diarrheal illnesses and inadequate access to health care, improvements in water supply and water quality will not result in reduction of disease deaths without explicit improvement in access to safe water among these populations (Rheingans *et al.* 2006). A more nuanced analysis of access to improved drinking water is warranted to better understand country and sub-national levels of access (JMP 2011). Such an analysis at the country level may influence policy and allocation of resources towards more marginalized areas.

The Philippines has reached the MDG target for water (JMP 2012a). In 1990, 85% of the population had access to improved water for drinking. By 2010, that number had improved to 92%; 43% had access to piped water to their home or plot, while 49% had access to other improved

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water sources (JMP 2012a): predominantly bottled or refilled water, two very common sources of water in the Philippines, especially in more urban areas (Israel 2009). When accompanied by access to an improved source for cooking and hygiene, bottled water is considered to be an improved water source (JMP 2012a). The Philippines has a smaller portion of the population using unimproved water sources (8%) than the average for South-eastern Asia (14%) and other lower middle income countries (12%) (LMICs). However, a lower proportion of the population of the Philippines has access to piped water (43%) than other LMICs (55%) (JMP 2012b).

The Philippines has a history of socio-economic and educational inequity (Balisacon & Pernia 2002; Silva 2005; UNESCO 2010; Pede *et al.* 2012), including a Gini index of between 0.45 and 0.51 for the past four decades (World Bank 2012). Inequity within the Philippines has existed for years, but was made worse following government devolution in the 1990s. As sub-national regions became more autonomous, already existing inequities became exacerbated (Silva 2005). The Autonomous Region of Muslim Mindanao in the south of the country, for example, is at the bottom of the country's gross domestic product parameters, while the capital, Manila, and the surrounding regions are at the highest (Clausen 2010). Only the regions surrounding Manila are expected to meet the MDG for poverty alleviation. None of the regions in the south will achieve this goal (Sawada & Estudillo 2012).

The Philippines has among the lowest total water potential per capita of all Asian countries (Hale 2007), defined in this study as availability in both ground and surface water in million cubic meters (MCM) (Hale 2007; Pasimio 2011). According to the Philippines Water Code, the central government owns all water, and all uses of water must be approved and permitted by the water authorities. Water shortage is made worse by a history of government mismanagement and environmental degradation (Barba 2002), and many parts of the country frequently experience drought as a result of El Nino weather patterns (Monsod & Monsod 2003). The water shortage is expected to increase, especially as the country becomes more affected by global climate change (Pasimio 2011).

Accurate mapping of drinking water access and water potential could assist policy makers, donors, and service delivery providers to appropriately allocate resources. Similar methods have been used outside WASH. Minot & Baulch (2005) mapped poverty density in Vietnam and compared it with poverty incidence. They found that more poor people actually live in areas that had previously been considered less poor. This led the way for changes to the current poverty alleviation program so that those in need could be better targeted (Minot & Baulch 2005). In Sri Lanka, the mapping of poverty identified geographical poverty clusters and their association with agriculture that could then be specifically used for policy and intervention targeting (Amarasinghe *et al.* 2005). Similarly, other WASH organizations, including WaterAid in Malawi and Tanzania, have successfully used water mapping as a tool for advocacy and for providing a better understanding of the distribution and functionality of water points (Welle 2005).

Here we explore the sub-national, geographic distribution of water access and water potential in the Philippines and propose an approach to better understand inequity at a sub-national level. We accomplish this through using maps to visually represent data of regional differences in community and school water access, groundwater potential, and poverty. By demonstrating exactly where inequities are occurring and where increased resources and efforts are needed within the country, this approach could serve as a first step in improving the equitable access to water resources as part of the post-2015 MDG targets.

METHODS

This study was conducted as part of a multi-country collaboration between Emory University and UNICEF to assess equity of access to WASH in schools. Fieldwork for the Philippines was conducted from September through December 2011. Initial qualitative analysis found that regional disparities existed for population- and school-level WASH, especially in regard to access to safe water. The study was deemed by UNICEF to be program evaluation and not subject to ethical review as there were no human subjects.

Data sources

Data for this study came from a combination of Philippines national data, including the Basic Education

Information System, National Statistical Coordination Board and the National Anti-Poverty Commission, as well as United Nations data sources, including the UNICEF list of waterless municipalities, and the Demographic Health Survey (DHS; years 1998 and 2008) (Table 1). The variable *waterless municipalities per region* is defined by UNICEF as the number of municipalities per region in which 50% or more of households do not have access to safe water (Villaluna 2011). Water sources per region were defined based on WHO-UNICEF JMP definitions (JMP 2012b).

Geospatial analysis

We employed a geospatial analysis to show visually and statistically relationships and sub-national regional patterns using ArcGIS Version 10 (Redlands, CA). We mapped the following variables: A) poverty incidence among population; B) waterless municipalities per region; C) percentage schools without water per region; and D) total water potential.

Spatial autocorrelation analysis was conducted using GeoDa version 1.0.1 (Tempe, AZ). Global Moran's I and Moran's Local Indicators of Spatial Association (LISA) statistic were computed for each variable to determine the level of spatial autocorrelation among neighboring areas, as well as identify areas of localized clustering. Moran's I global statistic assesses whether a variable is significantly geographically dispersed, clustered or random (i.e. is there a spatially distinct pattern); the values can range from -1 (perfect geographical dispersion) to $+1$ (perfect geographical correlation) (Anselin 2003, 2005). The Moran's LISA statistic compares the values of a given variable between neighbors to identify areas of local spatial clustering (Anselin 2003, 2005). Neighborhood weighting was created using first order queen continuity, and a permutation procedure of 999 replications was used to test for significance (Anselin 2005).

Access to an improved water source, 1998–2008

DHS data for access to an improved water source were mapped for the years 1998 and 2008 (National Statistics Board 2009). Percentage change in access to an improved water source from 1998 to 2008 was calculated for the northern, central and southern portions of the country, based on the geographical divisions made in the DHS.

Table 1 | Data sources for variables used in study

Variable	Data source	Description
1 Percentage schools without water per region	Basic Education Information System; Philippines Department of Education; 2009–2010 school year	The Philippines system for monitoring schools. Includes information on WASH, as well as number and demographic of students, number of teachers, desks, etc. Data is collected annually at the school level
2 Waterless municipalities per region	UNICEF list of waterless municipalities; 2011	Municipalities were deemed 'waterless' if >50% of households did not have access to safe water. The percentage of waterless municipalities was then determined for each region
3 Poverty incidence among population	Philippine National Statistical Coordination Board; 2009	Poverty incidence among population estimates from the Philippines National Statistical Coordination Board in 2009
4 Total water potential	Philippine Senate Economic Planning Office, Policy Brief; August 2011	Total water potential, in million cubic meters (MCM), was matched to sub-national regions using the water resource map provided by the Philippines National Water Resource Board. Water potential includes both ground and surface water
5 Improved water sources per region	DHS; 1998–2008	Data on improved water sources for regions was provided by the DHS, and then categorized as 'improved' based on WHO-UNICEF JMP definitions

DISCUSSION AND RESULTS

Geospatial analysis

We found distinct patterns of considerable sub-national heterogeneity in all of the variables: poverty incidence among population, waterless municipalities per region, percentage of schools without water per region and total water potential (Figure 1(A)–(D)). All variables were found to have positive and significant Moran's I statistics ($p = 0.001$ for all), confirming significant spatial autocorrelation of each variable. Both household- and school-level water access were found to be higher in the north than in the south, yet total water potential was found to be highest in the southern regions. Poverty incidence, however, was found to be lowest in the northern regions with greater water access, and highest in the south.

Poverty incidence was greatly spatially correlated (Moran's $I = 0.9$). The northern regions, where incidence was 15–25% or <15%, had the least amount of poverty in the country (Figure 1(A)). Especially low was the National Capital Region that had a poverty incidence of 4%. Also in the north was clustering of low levels of poverty, significant at <0.5%. Poverty continued to increase further south. Poverty incidence was highest in the central and southern portions of the country. In the south, poverty incidence ranged from 35 to 50%, the highest in the country. Significant clustering of high levels of poverty was also found in the south.

There was a spatial trend in waterless municipalities (Moran's $I = 0.6$); there were more waterless municipalities in the central and southern regions, and fewer in the northern regions (Figure 1(B)). There were fewer waterless municipalities clustered in the north and a greater number clustered in the south ($p<0.05$). The lowest number of waterless municipalities was found in the north, where in some areas only 3% of municipalities per region were waterless. In the south, at the highest, up to 84% of municipalities per region were waterless.

The percentage of schools without water (Figure 1(C)) followed a similar pattern of spatial correlation (Moran's $I = 0.5$): fewer northern schools were without water than southern schools. There was significant clustering ($p<0.05$) of a low percentage of schools without water found in the north, and significant clustering of a high percentage of schools without water found in the central and southern regions. Many places in the north had 0–5% of schools without water. In the south, all regions had over 15% of schools without water, and some regions had well over a quarter of schools without access to water.

Total water potential followed a different pattern than the other variables (Figure 1(D)). There was significant ($p = 0.001$) spatial autocorrelation and the Moran's I value was the second highest of all the variables, demonstrating that total water potential is the most geographically patterned, after poverty incidence (Moran's $I = 0.8$; Table 2). However, unlike the other variables, significant high-high clustering was found in the south and significant low-low clustering was found in the north. The implication of this result is that the southern regions had clusters of high total water potential, and the northern regions had clusters of low total water potential. The south, which has the least access to safe water, has a greater amount of total water potential than the other regions of the country. The northeastern portion of the country, Ilocos Region, has the second lowest total water potential, 4,498 MCM, but also has the lowest percentage of waterless municipalities per region (<12%) and the lowest percentage of schools without water (<5%). The area of Northern Mindanao, the northern portion of the south, has the highest total water potential, reaching 31,116 MCM, but a comparatively high number of waterless municipalities and schools without water.

Access to an improved water source, 1998 to 2008

Geographic trends and clustering patterns were found to be similar in 1998 and 2008 (Figure 2). Access to an improved water source had a positive and significant Moran's I statistic in both years ($p = 0.001$), demonstrating significant spatial autocorrelation (Table 3). As has been seen with other development indicators, little changed in the ten-year period regarding inequities in water access. Access to improved water sources was greatest in the north in 1998 (93%) and 2008 (94%), relative to other regions; the northern region was the only one to experience a percentage

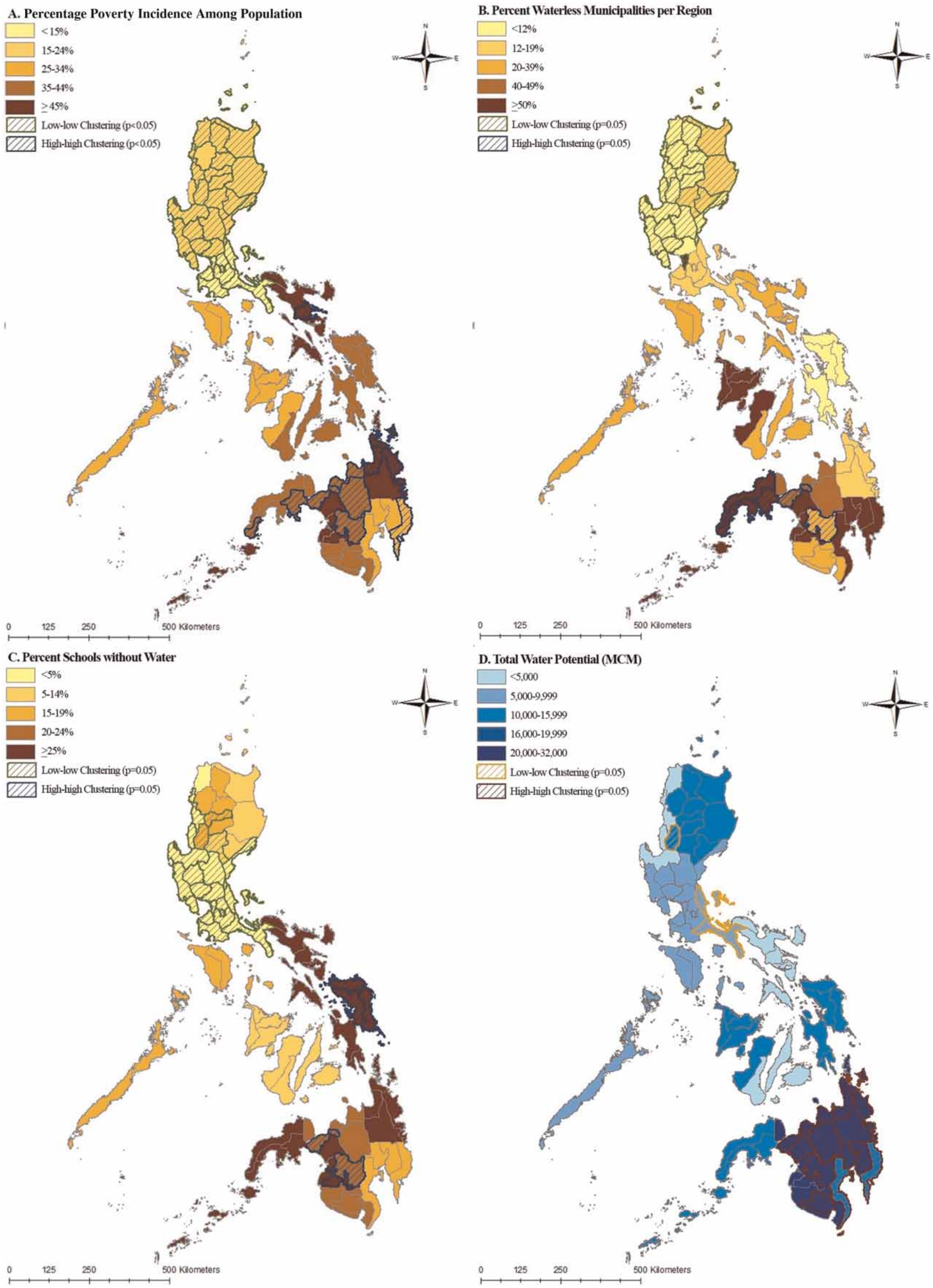

Figure 1 | Regional variation in (A) percentage poverty incidence among population; (B) percentage waterless municipalities per region; (C) percentage schools without water; and (D) total water potential.

Table 2 | Moran's I and significance of given variables in Figure 2

Variable	Moran's *I*	*p*-value
A) Poverty incidence among population	0.9	0.001
B) Percentage waterless municipalities per region	0.6	0.001
C) Percentage schools without water	0.5	0.001
D) Total water potential	0.8	0.001

change increase in access, although it was <1%. Water access in the central portion of the country decreased by 2% between 1998 (87%) and 2008 (85%). The southern regions also experienced slight, but negative changes in the percentage of the population with access to an improved water source: 75% of the population had access in 2008, down from 78% in 1998, resulting in a 3% decrease in access.

The results of this analysis confirm earlier studies that also found sub-national inequities in development indicators throughout the Philippines. In 2003, Monsod & Monsod found considerable sub-national inequities for many of the MDG indicators, including poverty and water. Specifically, they found households in the southern regions had 33 percentage points less access to water than those in the northern regions (Monsod & Monsod 2003). Since that was published, little has changed in eliminating the sub-national inequities in water access and poverty.

There are several potential reasons that regions with high total water potential do not also have increased access to improved drinking water sources, including governance, sociopolitical events, and climate, for example. Water governance in the Philippines is complex and involves multiple government departments and bureaus. As of 2002, over 30 government agencies were involved in some aspect of water management (Barba 2002). All water resources are controlled by the government, which has a history of mismanagement and environmental degradation (Pasimio 2011). A multitude of policies and regulations exist in regard to water, but many are limited in scope and

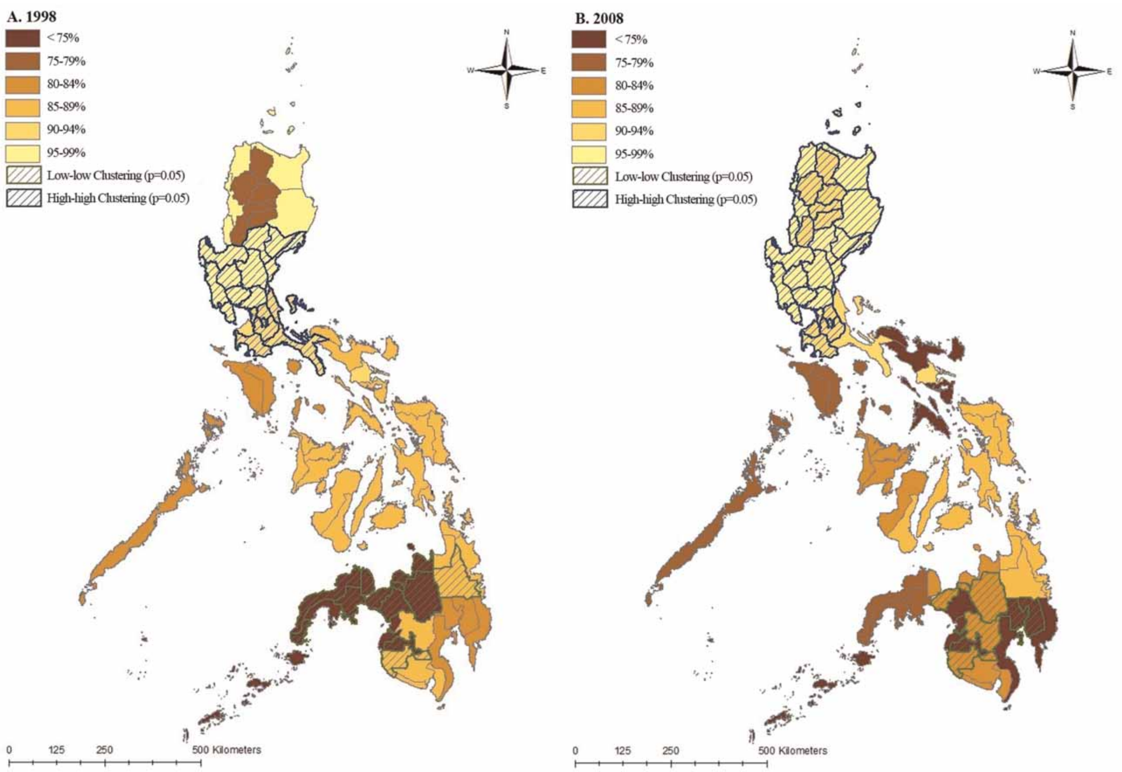

Figure 2 | Access to improved water source by region, DHS 1998 and 2008.

Table 3 | Moran's I and significance of access to an improved water source in 1998 and 2008

Year	Moran's *I*	*p*-value
1998	0.7	0.001
2008	0.6	0.001

some are even conflicting (Bautista & Palanca-Tan 2003). There have been inadequate investments in WASH infrastructure and the local government units are responsible for providing the water supply subsystems (Barba 2002; Pasimio 2011). These administrative units are more susceptible to the effects of poverty (Silva 2005), and therefore regions with higher levels of poverty are less likely to have access to an improved water source.

Another potential explanation is the conflict in the southern region of the country. There has been a long history of the south being disenfranchised, underrepresented in government, and lacking in the administering of social programs and infrastructure (Silva 2005; Clausen 2010). For example, parts of Mindanao were left out of government-supported agriculture services for 20 years at the end of the 20^{th} century, leaving the southern regions at a disadvantage not experienced by the northern regions (Clausen 2010). And in the past, the more prosperous northern regions received all official development assistance funds, while the already marginalized south did not receive any (Silva 2005). Moro insurgent movements against the government have been present in the Philippines for more than 200 years. The Autonomous Region of Muslim Mindanao was established in 1996, but decades of conflict, have led to the destruction of infrastructure, as well as the death of over 120,000 people (Malapit *et al.* 2003). These conflicts have also limited the effectiveness of investments and policies aimed to alleviate sub-national inequities, further exacerbating inequities (Clausen 2010).

Climate has also been found to affect sub-national inequities, especially in regard to poverty. The Philippines is home to four distinct climate zones. A previous study has shown that poverty incidence is significantly associated with climate zone, and that there is a much greater percentage poverty – up to 17 percentage points – in the southern regions occupying a climate zone without a distinct dry period, compared with the National Capital Region and surrounding northern regions, which do have a distinct dry period (Monsod & Monsod 2003).

A limitation of this study was the use of multiple data sources. Each dataset has its own potential for bias, for example due to collection method, and data come from different years, and occasionally different administrative levels. Because of this, there are limitations in the number of applicable statistical tests that can be performed. There are other limitations in regard to confounding. It is not possible to statistically assess the extent to which the conflict in the south has had an impact on water, poverty or development.

CONCLUSION

The purpose of this study was to collect and visually represent sub-national data within the Philippines to explore regional inequities. A number of countries have made significant gains in water coverage in the past ten years. In the Philippines, we found regional differences in the extent of these gains. Though the southern regions have considerable rain and groundwater potential, they have not achieved similar levels of water access to the north. Geospatial correlations exist between sub-national regions and poverty and household- and school-level water access.

As has been done in other disciplines, especially food security and poverty studies (Hyman *et al.* 2005), we expect that our approach of visually representing sub-national inequities may provide utility for decisions by policy makers, donors, and service delivery providers on resource allocation. Our analysis visually identifies areas in the Philippines with low household and school WASH coverage. Further, the current areas with low coverage or little access to improved water sources have not changed in the past ten years. These gaps in coverage should become targeted for future WASH policies and programs – at both the household-level and the school-level (UNICEF 2012). Multiple factors need to be considered so that the country will not only achieve the MDG for water, but the entire population will have access to improved water and sanitation. Water is a fundamental human right and necessary for health and development. Sub-national factors, including geographical disparities, need to be the focus of further development efforts so that these equity issues are eliminated.

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